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| 10/057,014 | 01/24/2002 | Padmanabhan Krishnaraj | A5597/T41100 | 3611 |

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| EXAMINER | |
|---|---|
| SONG, MATTHEW J | |
| **ART UNIT** | **PAPER NUMBER** |
| 1765 | |

DATE MAILED: 11/19/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/057,014 | KRISHNARAJ ET AL. | |
| | Examiner | Art Unit | |
| | Matthew J Song | 1765 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on 1/24/02

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-23* is/are pending in the application.

4a) Of the above claim(s) *14-23* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-13* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. §§ 119 and 120**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *1,2,3,4*.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

## DETAILED ACTION

### *Election/Restrictions*

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

   I. Claims 1-13, drawn to a method, classified in class 117, subclass 84.

   II. Claims 14-18, drawn to an apparatus, classified in class 709, subclass 100.

   III. Claims 9-23, drawn to an apparatus, classified in class 118, subclass 723 R.

2. The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the apparatus as claimed can be used to practice another and materially different process, such as one where the plasma is terminated prior to flowing the etchant gas.

Inventions I and III are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the apparatus as claimed can be used to practice another and materially different process, such as one where the plasma is terminated prior to flowing the etchant gas.

Inventions II and III are unrelated. Inventions are unrelated if it can be shown that they are not disclosed as capable of use together and they have different modes of operation, different

functions, or different effects (MPEP § 806.04, MPEP § 808.01). In the instant case the different inventions are a computer readable storage medium having a computer readable program and a substrate processing system.

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Patrick Boucher on 9/10/2003 a provisional election was made with traverse to prosecute the invention of Group I, claims 1-13. Affirmation of this election must be made by applicant in replying to this Office action. Claims 14-23 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

***Claim Rejections - 35 USC § 102***

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

6. Claim 1-2 and 4-5 are rejected under 35 U.S.C. 102(b) as being anticipated by Moslehi (US 5,252,178).

Moslehi discloses a method of plasma processing comprising flowing plasma deposition or etch gases into a process chamber in a continuous mode followed by flowing plasma gases in a continuous mode (Abstract), this continuous mode reads on applicant's without terminating the plasma. Moslehi teaches Plasma enhanced chemical vapor deposition (PECVD) silicon dioxide deposition using a combination of TEOS or DES, oxygen and argon with a cleaning gas combination of $NF_3$, oxygen and argon (col 11, ln 1-10), this reads on applicant's first and second gas mixtures include silicon-containing gas and oxygen-containing gas and the etchant gas includes a fluorine-containing gas. Moslehi teaches four deposition and etching cycles using the same process gases for each deposition step (col 11, ln 15 to col 12, ln 45 and Fig 11). Moslehi discloses a local plasma processing and electrodes disposed within the chamber, this reads on applicant's plasma source disposed within the processing chamber (Fig 1 and col 3, ln 20-25). Moslehi discloses electrode lines are connected to a low frequency RF tuner and to ground to cause plasma generation (col 9, ln 15-35), where the difference in RF reads on applicant's applying an electrical bias to the substrate while flowing etchant gas.

7. Claims 1-2 and 4-5 are rejected under 35 U.S.C. 102(e) as being anticipated by Sandhu (US 2001/0028922).

Sandhu discloses reactant species include silicon species and oxygen species that can react to deposit a silicon dioxide film and an etchant gas of $CF_4$,$CHF_3$ and $NF_3$ can be used ([0022]-[0029]). Sandhu also discloses an AC generator creates and RF bias between the plasma

and substrate ([0033]). Sandhu also discloses providing a substrate in a plasma reactor and supplying process gases including a reactant species and etchant to the supper surface of the substrate and creating a plasma to deposit and etch the film (claim 1). Sandhu also teaches varying substrate bias or power can vary the deposition rate and conformality ([0038]). Sandhu also discloses varying the net deposition rate is continuously varied during the deposition by decreasing a partial pressure of the etchant in the reaction chamber (claims 1, 2, and 5), this reads on applicant's providing a first gaseous mixture, an etchant gas and a second gaseous mixture without terminating plasma because the deposition composition is continuously changed and contains both deposition gases and etchant gases.

***Claim Rejections - 35 USC § 103***

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

9. Claims 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Moslehi (US 5,252,178) or Sandhu (US 2001/0028922) in view of Wang et al (US 6,167,834).

Moslehi or Sandhu teaches all of the limitations of claim 2, as discussed previously, except the bias has a power density approximately between 0.9-3.2 $W/cm^2$. The electrical bias in plasma process is well known in the art to be a result effective variable, note Hausmann (US 6,099,697) and Sandhu (US 2001/0028922) ([0038]). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Moslehi by optimizing the electrical bias to obtain same by conducting routine experimentation of a result effective variable.

10. Claims 6-10 and 12-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sandhu (US 2001/0028922) in view of Lane et al (US 5,061,838).

Sandhu discloses reactant species include silicon species and oxygen species that can react to deposit a silicon dioxide film and an etchant gas of $CF_4$,$CHF_3$ and $NF_3$ can be used ([0022]-[0029]). Sandhu also discloses an AC generator creates and RF bias between the plasma and substrate ([0033]). Sandhu also discloses providing a substrate in a plasma reactor and supplying process gases including a reactant species and etchant to the supper surface of the substrate and creating a plasma to deposit and etch the film (claim 1). Sandhu also teaches varying substrate bias or power can vary the deposition rate and conformality ([0038]). Sandhu also discloses varying the net deposition rate is continuously varied during the deposition by decreasing a partial pressure of the etchant in the reaction chamber (claims 1, 2, and 5).

Sandhu does not teach the plasma includes poloidal ion flow along field lines substantially parallel to the surface interior to the process chamber and disposed to separate the plasma from the plasma coupling structure.

In a method of generating plasma, note entire reference, Lane et al teaches a toroidal ECR reactor in which a poloidal magnetic field **66** is established in a plasma generating chamber. Lane et al also teaches the flow along field lines is substantially parallel to a surface interior to the process chamber (Fig 1 and Fig 6). Lane et al also teaches a microwave source **44** for generating plasma, this read on applicant's plasma coupling structure because it generates a plasma. Lane et al also teaches the magnetic field configuration controls the plasma to guide it to the wafer while maintaining the plasma source region of the line of sight of the wafer (col 3, ln 45-68), this reads on applicant's poloidal flow is disposed to separate the plasma from the plasma coupling structure. Lane et al also teaches the wafer can be powered with a RF source to create additional biasing if ion bombardment energies greater than 20eV are desired (col 4, ln 25-50). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Sandhu's plasma process with Lane et al's poloidal magnetic field to produce a more uniform plasma flux (col 14, ln 5-20 and col 6, ln 10-45).

Referring to claim 7, the combination of Sandhu and Lane et al teaches varying the net deposition at least one time during deposition by decreasing the partial pressure of the etchant in the reaction chamber, this reads on applicant's second gaseous mixture with terminating the plasma ('922 claims 1 and 5).

Referring to claim 8, the combination of Sandhu and Lane et al teaches an RF bias between the plasma and the substrate ('922 [0033]).

Referring to claims 9-10, the combination of Sandhu and Lane et al is silent to the power density. The electrical bias in plasma process is well known in the art to be a result effective variable, note Hausmann (US 6,099,697) and Sandhu (US 2001/0028922) ([0038]). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Sandhu and Lane et al by optimizing the electrical bias to obtain same by conducting routine experimentation of a result effective variable.

Referring to claim 12-13, the combination of Sandhu and Lane et al teaches a second gas mixture with a decreased partial pressure of etchant gas, this reads on applicant's second deposition gas is the same as the first deposition gas. The combination of Sandhu and Lane teaches silicon and oxygen containing gases and fluorine containing etchant gases.

11. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sandhu (US 2001/0028922) in view of Lane et al (US 5,061,838) as applied to claims 6-10 and 12-13 above, and further in view of Tobe et al (US 5,891,349).

The combination of Sandhu and Lane et al teaches all of the limitations of claim 11, as discussed previously, except the plasma is high-density plasma.

In a method of plasma enhanced CVD, note entire reference, Tobe et al teaches high density plasma has attracted attention of semiconductor engineers in plasma processing methods because high density plasma enables novel processing and improves processing efficiency. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify to modify the combination of Sandhu and Lane et al with Tobe's high-density plasma to improve processing efficiency in a plasma process.

12. Claims 6-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lin (US 5,920,792) in view of Lane et al (US 5,061,838).

Lin teaches a high density plasma chemical vapor deposition (HDP-CVD) comprising forming a first layer on a substrate using a HDP-CVD composition, which contains a etching component and a deposition component and forming a second layer using a second composition which contains the same etching and deposition components but with a lower etching/depositing component ratio, this reads on applicant's second gaseous mixture without terminating the plasma (Claim 1).

Lin is silent to generating a plasma from a plasma coupling structure, wherein the plasma includes poloidal ion flow along field lines substantially parallel to a surface interior to the process chamber and disposed to separate the plasma from the plasma coupling structure.

In a method of generating plasma, note entire reference, Lane et al teaches a toroidal ECR reactor in which a poloidal magnetic field **66** is established in a plasma generating chamber. Lane et al also teaches the flow along field lines is substantially parallel to a surface interior to the process chamber (Fig 1 and Fig 6). Lane et al also teaches a microwave source **44** for generating plasma, this read on applicant's plasma coupling structure because it generates a plasma. Lane et al also teaches the magnetic field configuration controls the plasma to guide it to the wafer while maintaining the plasma source region of the line of sight of the wafer, this reads on applicant's poloidal flow is disposed to separate the plasma from the plasma coupling structure. It would have been obvious to a person of ordinary skill in the art at the time of the

invention to modify Lin's plasma process with Lane et al's poloidal magnetic field to produce a more uniform plasma flux (col 14, ln 5-20 and col 6, ln 10-45)

Referring to claim 8, the combination of Lin and Lane et al teach applying a bias to the wafer using RF power, this reads on applicant's applying an electrical bias to the substrate.

Referring to claims 9-10, the combination of Lin and Lane al is silent to the power density. The electrical bias in plasma process is well known in the art to be a result effective variable, note Hausmann (US 6,099,697) and Sandhu (US 2001/0028922) ([0038]). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Lin and Lane al by optimizing the electrical bias to obtain same by conducting routine experimentation of a result effective variable.

Referring to claims 11-12, the combination of Lin and Lane et al teaches a high density plasma process where the same etching and deposition gases are used in both layers, this reads on applicant's second deposition gas is substantially the same as the second gas (col 7, ln 45-55 and Claim 1).

***Conclusion***

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Hausmann (US 6,099,697) teaches electrical bias and other chamber conditions are optimized during wafer processing in a plasma process (col 1, ln 24-65).

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 703-305-2667. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS

NADINE G. NORTON
SUPERVISORY PRIMARY EXAMINER